Original Article

# Identification of preadmission predictors of outcome of noninvasive ventilation in acute exacerbation of chronic obstructive pulmonary disease

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**Abstract**

**Background:** Noninvasive ventilation (NIV) has been shown to be an effective treatment for ventilatory failure, particularly resulting from acute exacerbations of chronic obstructive pulmonary disease (COPD). However, NIV is associated with significant failure rates. Hence, there is a need for identifying preadmission predictors for outcome of NIV in patients for acute exacerbation of COPD, thereby sparing the discomfort of a trial of NIV on these patients. **Aim:** The study was carried to identify the preadmission predictors of outcome of NIV in acute exacerbation of COPD with respiratory failure. **Material and Methods:** The study was carried in the Department of TB & Chest diseases at the Jawaharlal Nehru Medical College, AMU; 250 patients with acute exacerbation of COPD were enrolled in the study. These patients were grouped on the basis of six different independent variables, viz. age, performance status, pH, late failures, $SaO_2$, and presence or absence of pedal edema. Analysis was done by z-test, P<0.001 was considered significant. **Observation:** Age had no impact on the outcome of patient on NIV ($z$ = 0.3).The risk for endotracheal intubation was found to be increased by the presence of pedal edema ($z$ = 6.2; P < 0.001), $O_2$ saturation of less than 86% ($z$ = 4.7; P < 0.001), and acidemia (pH < 7.3) on admission ($z$ = 10.6; P < 0.001). In addition, poor performance status of limited self-care ($z$ = 3.2; P < 0.01) and late failures carried poor outcome of NIV ($z$= 8.3; P < 0.001). **Conclusion:** Patients' COPD with poor baseline performance status, pedal edema, low oxygen saturation, and academia carry a high likelihood of failure and should be spared a prolonged trial of NIV.

**Key Words:** Chronic obstructive pulmonary disease, Endotracheal intubation, Noninvasive ventilation

## Introduction

The use of noninvasive ventilation (NIV) in the management of chronic obstructive pulmonary disease (COPD) is now supported by a number of randomized controlled trials.[1–5] It has been shown to reduce intubation rates,[3–5] mortality,[2–5] and length of hospital stay.[1–4] It has the advantage that it can be applied intermittently, avoids the need for sedation, and allows the patient to eat, drink, and speak. The incidence of nosocomial pneumonia during NIV is lower than in intubated patients.[6] However, NIV is not successful in all cases of acute on chronic respiratory failures owing to COPD, with reported failure rates of 7–50%.[4] There has also been concern that NIV may delay intubation, leading to a worse outcome.[7,8] The ability to predict those likely to fail with NIV is important. Patients in whom there is a likelihood of failure would be spared the discomfort of a trail of NIV and intubation would not be delayed.

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## Materials and Methods

The study was carried in the Department of TB & Chest Diseases, Jawaharlal Nehru Medical College, AMU, between January 2001 and June 2003. Bilevel positive airways pressure (model-horizon) was used for the study. The patients were managed in the high dependency unit in the Department of Tuberculosis and Chest Diseases; 250 patients with acute exacerbation of COPD were enrolled in the study. Informed consent was taken from all these patients. The following data were obtained for all patients before initiation of NIV: age, sex, weight, vital signs (systemic arterial blood pressure, heart rate, and respiratory rate). Arterial blood gas analysis (ABG) was obtained at regular intervals (0 h, 30 min, 1 h, 2 h). All patients were given conventional medical therapy in addition to NIV. The inclusion criteria were respiratory distress with respiratory rate more than 24/min, pH range 7.2–7.42, $SaO_2$ between 82% and 98%, performance status ranging from normal activity (NA) to bed care and no self-care (BC), presence of pedal edema, late failures (i.e., deterioration after 48 h of NIV). *Exclusion criteria* were cardiac or respiratory arrest, upper gastrointestinal bleed, comatose patients, hypotension inspite of inotropes, arrhythmias, poor gag reflex, and pH < 7.20. *Criteria for NIV discontinuation and endotracheal intubation* were mask intolerance owing to pain, discomfort, or claustrophobia, inability to improve gas exchange after 2 h of NIV, hemodynamic instability or evidence of cardiac ischemia or ventricular dysarrhythmia, and need for urgent endotracheal intubation to manage secretions or protect the airways. NIV was applied initially for 2 h to assess the improvement (ABG was done at 0 h, 30 min,1 h, and 2 h). However, if the patient falls under the criteria for NIV discontinuation and endotracheal intubation before 2 h, the trail of NIV was discontinued. The starting pressures were as follows: 6 cm $H_2O$ Inspiratory Positive Airway Pressure (IPAP) and 4 cm $H_2O$ Expiratory Positive Airway Pressure (EPAP) (difference of at least 2 cm $H_2O$ was maintained), it was gradually increased according to patient compliance up to maximum IPAP of 18 cm $H_2O$ and EPAP of 16 cm $H_2O$. Statistical analysis was done by *z*-test, $P < 0.01$ was considered statistically significant.

## Observation

Data available at the time of NIV is initiated and after a short period (30 min, 1 h) can predict the likelihood of success or failure with reasonable degree of precision. Out of 250 patients enrolled in the study, most of the patients were of age group 70–75 ($n$=70) and 27% of patient of this age group (19 patients) had to undergo endotracheal intubation; however, the result was statistically not significant (Table 1; Figure 1).

Patients with performance status of limited self-care carry worst prognosis as compared with patients with normal activity ($z$= 3.2; $P < 0.01$), as compared with patients of limited strenuous activity ($z$= 3.0; $P < 0.01$), as compared with patients of bed care and no self-care ($z$= 0.2; not significant, Table 2; Figure 2). Patients with oxygen saturation in the range 92–98% at the time of admission carry better prognosis ($z$=4.7; $P < 0.001$) as compared with patients with oxygen saturation < 92% (Table 3; Figure 3).Patients with pH range 7.20–7.26 carry poor prognosis and require endotracheal intubation; (Table 4; Figure 4). Patients with pedal edema indicating cor–pulmonale carry poor prognosis ($P < 0.001$,

**Table 1: Effect of age on outcome of NIV**

| Age (years) | Number of patients | Patients requiring endotracheal intubation | Statistical analysis ($z$) |
|---|---|---|---|
| 50–55 | 25 | 6 | 0.3 |
| 55–60 | 30 | 7 | 0.4 |
| 60–65 | 50 | 10 | 0.8 |
| 70–75 | 70 | 19 | 0 |
| 75–80 | 25 | 8 | 0.5 |

**Table 2: Effect of performance status on outcome of NIV**

| Performance status | Number of patients | Patients requiring endotracheal intubation | Statistical analysis |
|---|---|---|---|
| NA | 20 | 1 | $z$ = 3.2; $P < 0.01$ |
| Strenuous activity (SA)—limited | 30 | 4 | $z$ = 4; $P < 0.01$ |
| Limited but self-care (L/SC) | 90 | 20 | $z$ = 3; $P < 0.01$ |
| Limited self-care | 70 | 30 | |
| BC | 40 | 18 | $z$ = 0.2; $P < 0.2$ |

**Table 3: Effect of oxygen saturation ($SaO_2$) on outcome of NIV**

| $SaO_2$ | Number of patients | Patients requiring endotracheal intubation | Statistical analysis |
|---|---|---|---|
| 82–86 | 150 | 75 | |
| 86–92 | 50 | 18 | $z$ = 1.75 |
| 92–98 | 50 | 6 | $z$ =4.7; $P < 0.001$ |

**Table 4: Effect of pH on outcome of NIV**

| pH | Number of patients | Patients requiring endotracheal intubation | Statistical analysis |
|---|---|---|---|
| 7.2–7.26 | 150 | 100 | |
| 7.26–7.34 | 50 | 8 | $z$ = 10.6; $P < 0.001$ |
| 7.35–7.42 | 50 | 10 | $z$ = 5.8; $P < 0.001$ |

Table 5; Figure 5). Patients who deteriorate after 48 h of NIV (late failures) had poor outcome ($P < 0.001$, Table 6; Figure 6).

## Discussion

A number of studies have looked at predictors of outcome fro NIV in acute exacerbations of COPD.[1,2,9–11] Acidosis is an indicator of the severity of decompensation in acute on chronic ventilatory failures and has been shown to predict death or patient requiring endotracheal intubation owing to acute exacerbation of COPD.[2,9,11]

**Table 5: Effect of pedal edema on outcome of NIV**

| Pedal edema | Number of patients | Patients requiring endotracheal intubation | Statistical analysis |
|---|---|---|---|
| Present | 100 | 70 | $z = 6.2$; $P < 0.001$ |
| Absent | 150 | 20 | |

**Table 6: Effect of late failures on outcome of NIV**

| Late failures | Number of patients | Patients requiring endotracheal intubation | Statistical analysis |
|---|---|---|---|
| Deterioates after 48 h | 100 | 70 | |
| Does not deterioate | 150 | 30 | $z = 8.3$; $P < 0.001$ |

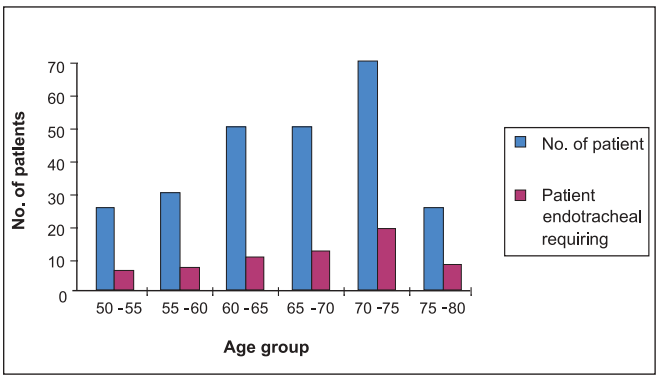


**Figure 1:** Shows impact of age on outcome of NIV

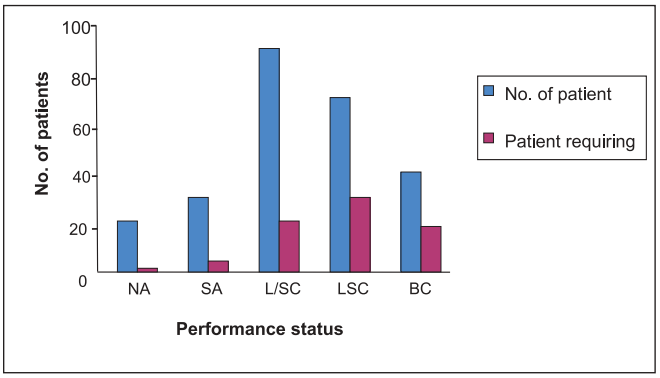


**Figure 2:** Shows impact of performance status on outcome of NIV

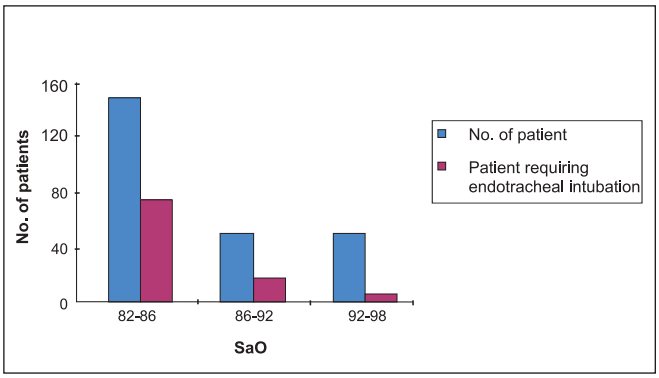


**Figure 3:** Shows impact of oxygen saturation ($SaO_2$) on outcome of NIV

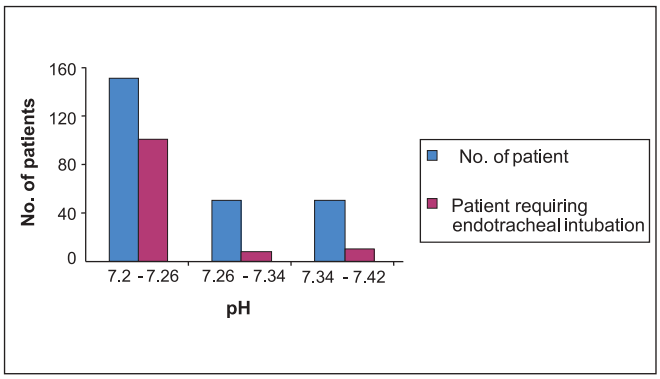


**Figure 4:** Shows impact of pedal edema on outcome of NIV

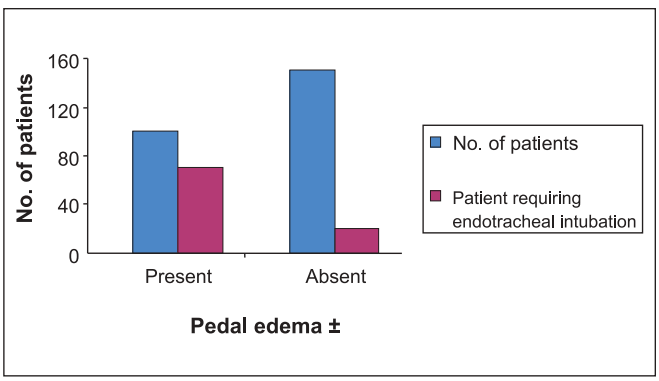


**Figure 5:** Shows impact of pH on outcome of NIV

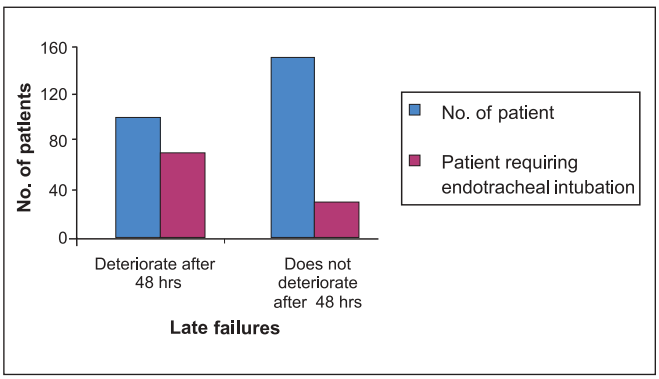


**Figure 6:** Shows impact of late failures on outcome of NIV

Ambrosino *et al.* found that patients in whom NIV treatment failed were significantly more acidemic at baseline than those successfully treated. Although using discriminant analysis, a number of variables had a predictive value of more than 0.80 for successful NIV, when tested together using regression analysis, only baseline pH remained as a significant predictor for successful NIV, with a sensitivity of 91% and specificity of 71%. Brochard *et al.*[1] found that success was less likely with a lower starting pH.

Ambrosin *et al.*[12] found that better compliance was associated with a greater likelihood of success with NIV. Studies have concentrated on the ability to predict failures shortly after initiation of NIV. However, patients who fail NIV do not exclusively fail at this time. Late failures (deteriorating after 48 h of NIV) are recognized with rates reported at 0–20% and have been associated with poor outcomes.[13] Age in our study was unrelated to outcome, a fact consistent with the observation of other authors,[14–16] indicating that NIV needs not be denied to older patients. In our study patients with limited self-care or patient with a low level of consciousness carry poor prognosis—the result is in accordance to the American Respiratory Care Foundation,[17] which stresses that altered consciousness should be a relative contraindication for NIV, given that confused patients are likely to adapt poorly to NIV as a result of impaired collaboration.

Oxygen saturation ($SaO_2$) at the time of admission can predict outcome of the patient, as in our study, but no randomized control trial had been done earlier addressing this issue.

Patient with pedal edema indicating right-sided cardiac failure (cor–pulmonale) carries poor prognosis. This may be owing to the fact that peripheral pooling of blood further compromises oxygen delivery to the tissues, thereby increasing the work of breathing, which may lead to respiratory failure.

In conclusion, acidemia (pH < 7.2) should be considered as an absolute indication for endotracheal intubation. As seen in our study, out of 150 patients with pH < 7.26, 100 (66%) patients had to undergo endotracheal intubation; therefore, in our opinion, such patients should be spared of the discomfort of NIV, and should be taken up for invasive ventilation at the time of admission without a trial of NIV. Other variables, viz., late failures, performance status of limited self-care, $SaO_2$ (<86%), and presence of pedal edema, should be considered as relative contraindication to NIV. No difference in the outcome was noticed with increasing IPAP and EPAP (Table 6; Figure 6). No serious adverse effects were noticed. The minor complications were mild-to-moderate nasal bridge injury (25% of patients), conjunctivitis (6%), and gastric distension (2%).

## Conclusion

Acidosis is the most important predictor of outcome of NIV. As seen in our study that out of 150 patients with pH <7.26, 100 (66%) patients had to undergo endotracheal intubation, therefore, in our opinion such patients should be spared of the discomfort of NIV, and should be taken up for invasive ventilation at the time of admission without giving trial of NIV, whereas other variables, viz., late failures, performance status of limited self-care, $SaO_2$ (<86%), and the presence of pedal edema should be considered as relative contraindication to NIV.

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